What is claimed is:

1. A method of using an ionization signal to perform an engine diagnostic routine comprising:

a) detecting the ionization signal;

b) integrating said ionization signal over a first sampling window to generate a first integration ionization value;

c) detecting a peak of said ionization signal over said first sampling window to generate a first peak ionization value;

d) integrating said ionization signal over a second sampling window to generate a second integration ionization value;

e) detecting a peak of said ionization signal over said second sampling window to generate a second peak ionization value; and

f) performing the engine diagnostic routine with at least one of said first integration ionization value, said first peak ionization value, said second integration ionization value, and said second peak ionization value.

2. The method of claim 1 wherein said step of performing said engine diagnostic routine comprises:

performing the engine diagnostic routine during engine crank mode; or

performing the engine diagnostic routine during normal engine operational mode, wherein said step a) through step e) are performed for at least two banks of cylinders.

3. The method of claim 1 wherein said step of performing the engine diagnostic routine comprises:

comparing said first peak ionization value to a failed coil/ion-sensing threshold;

declaring an ignition coil/ion-sensing assembly fault if said first peak ionization value is less than said failed coil/ion-sensing threshold;

comparing said second peak ionization value to a sensor/input short to battery threshold;

declaring a sensor short to battery fault if said second peak ionization value is less than said sensor short to battery threshold; and

performing a cylinder identification routine by:

subtracting said first integration ionization value for a cylinder in a second bank of cylinders from said first integration ionization value for a cylinder in a first bank of cylinders to create a first difference;

comparing said first difference to said cylinder identification threshold and setting a cam synchronization flag for said cylinder in said first bank in compression when said first difference exceeds said cylinder identification threshold;

subtracting said first integration ionization value for said cylinder in said first bank of cylinders from said first integration ionization value for said cylinder in said second bank of cylinders to create a second difference; and

comparing said second difference to said cylinder identification threshold and setting a cam synchronization flag for said cylinder of said second bank in compression when said second difference exceeds said cylinder identification threshold.

4. The method of claim 3 further comprising:

adjusting a coil charge duration in a stepwise manner if said first difference and said second difference do not exceed said cylinder identification threshold; and

wherein said stepwise adjustment of said coil charge duration comprises the steps of:

adding said first integration ionization value for said cylinder in said second bank of cylinders to said first integration ionization value for said cylinder in said first bank of cylinders to create a sum;

comparing said sum to an ignition threshold value;

increasing said coil charge duration when said sum exceeds said ignition threshold value; and

decreasing said coil charge duration when said sum does not exceed said ignition threshold value.

5. The method of claim 1 further comprising:

determining whether a crank sensor is synchronized;

determining whether a cam synchronization flag is set;

determining whether a coil in a cylinder bank is charged; and

performing a crank mode diagnostic routine when said crank sensor is synchronized, said cam synchronization flag is not set, and said coil in said cylinder bank is charged.

6. The method of claim 1 further comprising:

determining whether a crank sensor is synchronized;

determining whether a cam synchronization flag is set;

determining whether an ignition dwell is active; and

performing a normal operational mode diagnostic routine when said crank sensor is synchronized, said cam synchronization flag is set, and said ignition dwell is active.

7. The method of claim 1 wherein said step of performing said engine diagnostic routine comprises:

comparing said first peak ionization value to a failed coil/ion-sensing threshold;

declaring an ignition coil/ion-sensing assembly fault when said first peak ionization value is less than said failed coil/ion-sensing threshold;

comparing said second peak ionization value to a sensor short to battery threshold;

declaring a sensor short to battery fault when said second peak ionization value is less than said sensor short to battery threshold;

comparing said first integration ionization value with an open secondary threshold;

declaring an open secondary fault when said first integration ionization value is less than said open secondary threshold; and

determining when said fuel system is active.

8. The method of claim 7 further comprising:

performing a misfire and partial burn diagnostic routine, said misfire and partial burn diagnostic routine comprising:

comparing said second peak ionization value to a partial misfire threshold;

comparing a corrected value of said second integration value to a misfire threshold;

declaring a normal combustion when said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold;

declaring a partial-burn when only one of said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold; and

declaring a misfire when neither of said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold.

9. A computer system for performing an engine diagnostic routine comprising:

a memory containing a program which performs the steps of:

a) detecting an ionization signal;

b) integrating said ionization signal over a first sampling window to generate a first integration ionization value;

c) detecting a peak of said ionization signal over said first sampling window to generate a first peak ionization value;

d) integrating said ionization signal over a second sampling window to generate a second integration ionization value;

e) detecting a peak of said ionization signal over a second sampling window to generate a second peak ionization value; and

f) performing said engine diagnostic routine with at least one of said first integration ionization value, said first peak ionization value, said second integration ionization value, and said second peak ionization value; and

a processor for running said program.

10. The computer system of claim 9 wherein said program further performs the steps of:

comparing said first peak ionization value to a failed coil/ion-sensing threshold;

declaring an ignition coil/ion-sensing assembly fault when said first peak ionization value is less than said failed coil/ion-sensing threshold;

comparing said second peak ionization value to a sensor short to battery threshold;

declaring a sensor short to battery fault when said second peak ionization value is less than said sensor/input short to battery threshold; and

performing a cylinder identification routine by subtracting said first integration ionization value for a cylinder in a second bank of cylinders from said first integration ionization value for a cylinder in a first bank of cylinders to create a first difference;

comparing said first difference to said cylinder identification threshold and setting a cam synchronization flag for said first bank of cylinders when said first difference exceeds said cylinder identification threshold;

subtracting said first integration ionization value for said cylinder in said first bank of cylinders from said first integration ionization value for said cylinder in said second bank of cylinders to create a second difference; and

comparing said second difference to said cylinder identification threshold and setting a cam synchronization flag for said second bank of cylinders if said second difference exceeds said cylinder identification threshold.

11. The computer system of claim 10 wherein said program adjusts a coil charge duration in a stepwise manner when said first difference and said second difference do not exceed said cylinder identification threshold, by:

adding said first integration ionization value for said cylinder in said second bank of cylinders to said first integration ionization value for said cylinder in said first bank of cylinders to create a sum;

comparing said sum to an ignition threshold value;

increasing said coil charge duration if said sum exceeds said ignition threshold value; and

decreasing said coil charge duration if said sum does not exceed said ignition threshold value.

12. The computer system of claim 9 wherein said program performs a normal engine operation diagnostic routine, said normal engine operation diagnostic routine comprising:

comparing said first peak ionization value to a failed coil/ion-sensing threshold;

declaring an ignition coil/ion-sensing assembly fault when said first peak ionization value is less than said failed coil/ion-sensing threshold;

comparing said second peak ionization value to a sensor short to battery threshold;

declaring a sensor short to battery fault when said second peak ionization value is less than said sensor/input short to battery threshold;

comparing said first integration ionization value with an open secondary threshold;

declaring an open secondary fault when said first integration ionization value is less than said open secondary threshold; and

determining when said fuel system is active.

13. The computer system of claim 12 wherein said program performs a misfire and partial burn diagnostic routine, said misfire and partial burn diagnostic routine comprising:

comparing said second peak ionization value to a partial misfire threshold;

comparing a corrected value of said second integration value to a misfire threshold;

declaring a normal combustion when said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold;

declaring a partial-burn when only one of said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold; and

declaring a misfire when neither of said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold.

14. The computer system of claim 9 wherein said program performs the following steps before performing a crank mode engine diagnostic routine:

determining whether a crank sensor is synchronized;

determining whether a cam synchronization flag is set;

determining whether a coil in at least one cylinder bank is charged; and

wherein said program performs said crank mode diagnostic routine when said crank sensor is synchronized, said cam synchronization flag is not set, and said coil in said at least one cylinder bank is charged; and further wherein said program performs the following steps before performing a normal engine operation diagnostic routine:

determining whether a crank sensor is synchronized;

determining whether a cam synchronization flag is set;

determining whether an ignition dwell is active; and

performing a normal operational mode diagnostic routine when said crank sensor is synchronized, said cam synchronization flag is set, and said ignition dwell is active.

15. A computer-readable medium whose contents cause a computer system to perform an engine diagnostic routine, the computer system having a program which executes the steps of:

a) detecting an ionization signal;

b) integrating said ionization signal over a first sampling window to generate a first integration ionization value;

c) detecting a peak of said ionization signal over said first sampling window to generate a first peak ionization value;

d) integrating said ionization signal over a second sampling window to generate a second integration ionization value;

e) detecting a peak of said ionization signal over a second sampling window to generate a second peak ionization value; and

f) performing said engine diagnostic routine with at least one of said first integration ionization value, said first peak ionization value, said second integration ionization value, and said second peak ionization value.

16. The computer readable medium of claim 15 wherein said program further executes the steps of:

comparing said first peak ionization value to a failed coil/ion-sensing threshold;

declaring an ignition coil/ion-sensing assembly fault when said first peak ionization value is less than said failed coil/ion-sensing threshold;

comparing said second peak ionization value to a sensor short to battery threshold;

declaring a sensor short to battery fault when said second peak ionization value is less than said sensor short to battery threshold; and

performing a cylinder identification routine by:

subtracting said first integration ionization value for a cylinder in a second bank of cylinders from said first integration ionization value for a cylinder in a first bank of cylinders to create a first difference;

comparing said first difference to said cylinder identification threshold and setting a cam synchronization flag for said cylinder in said first bank of cylinders if said first difference exceeds said cylinder identification threshold;

subtracting said first integration ionization value for said cylinder in said first bank of cylinders from said first integration ionization value for said cylinder in said second bank of cylinders to create a second difference; and

comparing said second difference to said cylinder identification threshold and setting a cam synchronization flag for said second bank of cylinders when said second difference exceeds said cylinder identification threshold.

17. The computer readable medium of claim 16 wherein said program further executes the steps of:

adjusting a coil charge duration in a stepwise manner when said first difference and said second difference do not exceed said cylinder identification threshold, wherein said stepwise adjustment of said coil charge duration comprises the steps of:

adding said first integration ionization value for said cylinder in said second bank of cylinders to said first integration ionization value for said cylinder in said first bank of cylinders to create a sum;

comparing said sum to an ignition threshold value;

increasing said coil charge duration when said sum exceeds said ignition threshold value; and

decreasing said coil charge duration when said sum does not exceed said ignition threshold value.

18. The computer readable medium of claim 15 wherein said program further executes the steps of:

comparing said first peak ionization value to a failed coil/ion-sensing threshold;

declaring an ignition coil/ion-sensing assembly fault when said first peak ionization value is less than said failed coil/ion-sensing threshold;

comparing said second peak ionization value to a sensor short to battery threshold;

declaring a sensor short to battery fault when said second peak ionization value is less than said sensor/input short to battery threshold;

comparing said first integration ionization value with an open secondary threshold;

declaring an open secondary fault when said first integration ionization value is less than said open secondary threshold; and

determining when said fuel system is active.

19. The computer readable medium of claim 18 wherein said program further executes the steps of:

comparing said second peak ionization value to a partial misfire threshold;

comparing a corrected value of said second integration value to a misfire threshold;

declaring a normal combustion when said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold;

declaring a partial-burn when only one of said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold; and

declaring a misfire when neither of said second peak ionization value and said corrected value of said second integration value exceeds said partial misfire threshold.

20. The computer readable medium of claim 15 wherein said program further executes the steps of:

determining whether a crank sensor is synchronized;

determining whether a cam synchronization flag is set;

determining whether a coil in at least one cylinder bank is charged; and

performing said crank mode diagnostic routine when said crank sensor is synchronized, said cam synchronization flag is not set, and said coil in said at least one cylinder bank is charged;

determining whether a crank sensor is synchronized;

determining whether a cam synchronization flag is set;

determining whether an ignition dwell is active; and

performing a normal operational mode diagnostic routine when said crank sensor is synchronized, said cam synchronization flag is set, and said ignition dwell is active.